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NATIONAL DAM SAFETY PROGRAM. LAUREL BED DAM NUMBER (VA 16701), --ETC(U)
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TENNESSEE RIVER BASIN

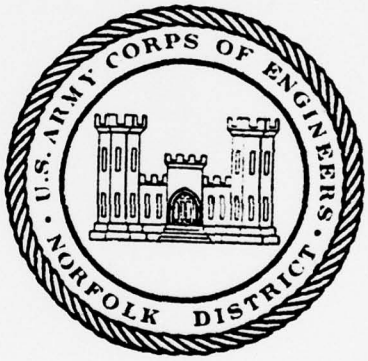
Name Of Dam: LAUREL BED DAM

Location: RUSSELL COUNTY, VIRGINIA

Inventory Number: VA 16701

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
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NORFOLK, VIRGINIA 23510

BY

GILBERT ASSOCIATES, INC.

AUGUST, 1978

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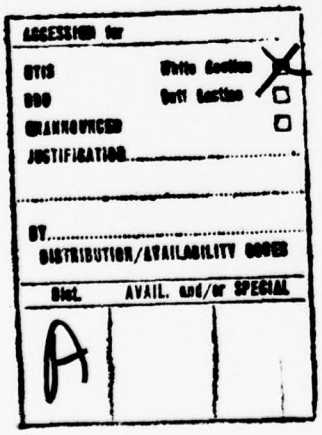
20. Abstract

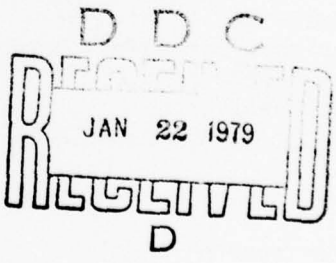
Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

LEVEL II





PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Laurel Bed
State:	Virginia
County:	Russell
USGS Quadrangle Sheet:	Saltville
Stream:	Laurel Bed Creek

The Laurel Bed Dam is an earth embankment dam about 45 feet high and 275 feet long. A spillway is cut through a natural saddle on the left abutment and the spillway chute is cut into the left slope discharging below the dam. The dam is used primarily for recreation but is occasionally used to augment flows through the recreational fishing area several miles below the dam. Two major items requiring action by the owner were identified which could become hazardous depending on conditions, and there were several other items warranting the owner attention. (See Appendix V, Conditions)

The spillway was found to pass 50 percent of the PMF flood before the dam would be overtopped, which does not meet the U.S. Corps of Engineers' inspection screening criteria but is sufficient such that the spillway is not "seriously inadequate," as defined in the U.S. Corps of Engineers' Engineer Technical Letter No. 1110-2-234. Improvement of the erosion resistance of the spillway crest is recommended.

There is little data available on the embankment stability, but it is known that the downstream slope is steeper than designed and the crest width is too narrow. These conditions are among those for which remedial measures are recommended below.

The following recommendations are presented for the Owner's consideration and implementation:

(1) Have a consultant perform a stability analysis of the embankment and make recommendations for widening the base and crest of the dam. This analysis should be carried out within 90 days.

(2) Improve the erosion resistance of the emergency spillway within 90 days. Future consideration should be given to enlarging the spillway to meet Corps of Engineer inspection guideline criteria.

(3) Establish an inspection program to monitor seepage conditions and any changes in the general condition of the dam.

(4) Develop, within 30 days, a detailed emergency warning system to notify the downstream area of impending danger, and determine, those areas subject to inundation from a dam break flood wave.

(5) Maintain a file of all available documents pertinent to the design, construction and operation of the dam.

(6) Remove dead trees from within the reservoir.

Until such time as the above recommendations can be implemented, during periods of heavy rainfall the owner should provide for round-the-clock surveillance of the dam and prepare to implement the warning system procedures recommended above.

Prepared By:

APPROVED:

Original signed by:

Douglas L. Haller

Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

21 AUG 1978

Date

Submitted By: Original signed by JAMES A. WALSH

Recomended By: Original signed by ZANE M. GOODWIN

June 5, 1978

LAUREL BED DAM
OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM Laurel Bed Dam ID# VA 16701

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the U.S. Corps of Engineers to initiate a national program of safety inspections of non-Federal dams throughout the United States. The Norfolk District of the U.S. Corps of Engineers has been assigned the responsibility of the inspection of dams in the Commonwealth of Virginia. Gilbert Associates, Inc. has entered into a contract with the Norfolk District to inspect this dam, Gilbert W.O. 06-7250-002.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1 of Appendix IV) and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify whether this dam apparently poses an immediate threat to human life or property, and to recommend future studies and/or any obvious remedial actions that may be indicated by the inspection.

1.2 Project Description

1.2.1 Dam and Appurtant Structures: Laurel Bed is a zoned earthfill embankment, 275 feet long and 45 feet high. The top width is 10 feet and the side slopes are at a nominal slope of 2-1/2 horizontal to 1 vertical downstream and 3 horizontal to 1 vertical upstream. Actual measurement in the field shows that the top 7 feet of the embankment on the downstream slope is at about a 2 horizontal to 1 vertical slope but the lower portion was closer to the design slope of 2-1/2 horizontal to 1 vertical.

The principal spillway has a drop-inlet entrance located at the water line on the upstream slope at the center of the dam. The inlet joins a vertical 36-inch diameter concrete shaft which leads to a 20-inch cast iron outlet pipe and also houses a 20-inch gate valve at its base. The inlet has a vertical face with a clear opening 3.0 feet wide. The inlet crest is at pool elevation 139.0 feet assumed datum.

The emergency spillway is formed by a natural saddle located at the left abutment. The spillway has a 25-foot flat bottom with sides at a 16.7 percent slope. Because a road across the top of the dam also crosses the spillway, the slopes of the spillway channel are blended to the bottom with a 10-foot long vertical curve transition. The channel consists of natural soils and runs level for 70 feet across the top of the left abutment. The downstream channel is excavated into the left abutment slope and parallels the intersection of the downstream embankment with the abutment slope.

For controlled releases, three outlets have been provided. The main outlet is located at the toe of the upstream slope. It is a 4.5-foot by 5.5-foot concrete box with a grating on the front and the top. The box is connected to a 20-inch iron pipe which leads to the gate valve located in the 36-inch spillway shaft. The two smaller outlets are located near the left abutment, one at a depth of 9 feet, at elevation 130 and the other at 19 feet, at elevation 120. These outlets feed an 8-inch pipe which leads to the 36-inch spillway shaft, intersecting at a depth of about 10 feet below the water surface. Both of these outlets are controlled from valves at the inlet end. Access to the valves is provided by a bridge extending out into the reservoir. The purpose of the smaller outlets is to allow a selective withdrawal from the reservoir, but according to a representative of the owner the 8-inch pipeline size is too small to to regulate downstream water temperatures.

1.2.2 Location: Laurel Bed Dam is in the Jefferson National Forest about 5.5 miles NNW of Saltville, Virginia, on Laurel Bed Creek.

1.2.3 Size Classification: The dam is classified as an intermediate structure based upon its storage volume (7,300 acre-feet), and also upon its height (45 feet), in accordance with Section 2.1.1 of Reference 1 of Appendix IV.

1.2.4 Hazard Classification: The dam is located above a recreational fishing area where there is potential for loss of life. Based upon the requirements of Section 2.1.2 of Reference 1 of Appendix IV, the dam is classified as a high hazard potential. The hazard classification used to categorize dams is a function of location only and unrelated to the stability or probability of failure.

1.2.5 Ownership: The dam is owned and maintained by the Commonwealth of Virginia, Commission of Game and Inland Fisheries. The engineering and maintenance of the dam are handled by the Engineering

Department of the Commission of Game and Inland Fisheries in Richmond, Virginia.

1.2.6 Purpose of Dam: The Laurel Bed Dam serves primarily to impound a recreational reservoir and also serves to augment Laurel Bed and Tumbling Creeks during low flow periods.

1.2.7 Design and Construction History: The dam was designed by Warren C. Perrow of Richmond, Virginia. The plans are dated October 1966, and the specifications, March 1967. The dam was constructed by Mills Branch Inc. of Grundy, Virginia, and it was completed in the fall of 1968.

1.2.8 Normal Operating Procedure: There is no formal operating procedure for the dam. Normally all outlets are closed and the waters pass over the principal spillway. When downstream augmentation is required, the main deep reservoir outlet is used but this is avoided as much as possible because of the loss of fish from the reservoir. According to the owner's representative the two shallower outlets are not typically used because the small pipeline size makes them ineffective.

1.3 Pertinent Data

1.3.1 Drainage Area: 4.16 square miles.

1.3.2 Discharge at the Dam Site: The maximum historic flood at the dam site is not known. Two small 8-inch warm water outlets are located at pool elevations 120.0 and 130.0 feet. The low pool outlet is at elevation 103.3.

Principal Spillway Discharge:

Pool level at emergency spillway crest	14 c.f.s.
Pool level at 100 year flood	40 c.f.s.
Pool level at top of dam	70 c.f.s.

Emergency Spillway Discharge:

Pool level at 100-year flood	170 c.f.s.
Pool level at top of dam	1300 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in Table 1.1. Elevations are based upon an assumed datum. The reservoir surface has an elevation of about 3560 feet m.s.l., based upon elevation contours given on the U.S.G.S. Quadrangle map.

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet (assumed datum)	Reservoir Area acres	Reservoir Volume Acre feet	Reservoir Capacity Watershed inches	Reservoir Length miles
Top of dam	145.0	387	7300	32.9	1.8
Emergency Spillway Crest	140.5	340	5500	24.8	-
Principal Spillway Crest	139.0	325	4900	22.1	1.7
Streambed at Centerline of Dam	98±	-	-	-	-

SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed by Warren C. Perrow of Richmond, Virginia. The designer is now deceased and his files are unavailable, but one set of plans and specifications is available at the Virginia Commission of Game and Inland Fisheries in Richmond, Virginia.

The plans and specifications show the embankment has three zones: a central clay core of the "best" material, an upstream zone of "second best" material, and a downstream zone of the "lowest grade material". It is assumed that "best," as used in the specifications, refers to the permeability, the highest grade being the least permeable, however the specifications do not define these terms. The material for all three zones is described as clay in the specifications. Surface material on the embankment was observed as predominantly clay with silt, and reddish sandstone and shale rock fragments. According to the plans and specifications the central core is roughly 19 feet wide at its base, and narrows toward the top at a 1 horizontal to 10 vertical slope. The core extends to the top of the dam making up the full 10-foot top width of the dam crest. A core trench with a minimum depth of 3.0 feet and the full width of the core is provided.

According the the owner's representative, plans are being formulated for repair and improvements to the dam. Nothing firm has been drawn up, but plans include repair of riprap, enlargement of the spillway, and the addition of more fill material to the downstream slope of the embankment.

2.2 Construction: The dam was constructed by Mills Branch Inc. of Grundy, Virginia, in 1968. No details of construction are available.

An area on the left abutment slope just downstream of the dam appears to have been a major borrow area for the embankment fill material.

2.3 Operation: Occasionally water is released to augment the flows in Tumbling Creek; however, no records are kept.

Immediately after the construction of the dam, a spring appeared in the spillway chute about 70 feet below the spillway crest. A small weir was installed and the depths over the weir were measured from March through July 1970. The dimensions of the weir were not available but the owner's representative believed the width was approximately 12 inches. The depth measured dropped from 2 inches in April to 1.25 inches in July. This would

represent a reduction in flow rate from 80 gpm to 40 gpm. The spring is still present and was estimated to be flowing at about 30 gpm at the time of the inspection.

From discussions with the engineering office of the Commission of Game and Inland Fisheries, we were informed that another spring had existed on the left slope, upstream of the dam prior to filling the reservoir. During a period when the reservoir had been drained, this spring reappeared and the spring in the spillway chute ceased to flow.

2.4 Evaluation: Except as noted below the plans and specifications were consistant with existing structures as observed. There is no detailed information available on the soils and geology of the site and no stability analysis of the embankment. There is no information on the hydrology of the site or the basis of the spillway design.

Some small differences were noted between the dam as constructed and the details shown on the plans. The downstream slope of the embankment is steeper near the top than is shown on the plan. It appears that during construction the fill for the downstream toe of the dam was started too close to the centerline of the dam. As the height of the fill increased it may have become necessary to steepen the slope in order to achieve the required top width. The spillway shaft is 36 inches rather than 42 inches, and the principal spillway crest appears to have been constructed 1 foot lower than the 140.0-foot elevation shown on the plans. The location of the spillway chute and outlet discharge point were also changed as shown on the Plan View in Appendix I.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: Conditions requiring the owner's attention which were revealed by the visual inspection include the condition of the riprap on the upstream slope, the spillway and some seepage.

The riprap consisted of large flat stones scattered about the upstream slope. There were gaps of unprotected areas between the stones and there did not appear to be a filter layer between the riprap and the embankment material. It would appear that the original stone layer had been scattered by waves and ice, but there was only minor erosion of the embankment.

The outlets were not operated during the inspection but were reported by the owner's representative to function normally. The principal spillway incorporates a portion of the outlet works. At the time of the inspection the water was flowing 1.1 feet deep over the sill and there were no apparent problems. As mentioned previously, the principal spillway was constructed lower and with a smaller shaft diameter than shown on the plans.

The emergency spillway had a light covering of weeds and its surface consisted primarily of the native soils. Although the surface materials appeared to lack erosion resistance there was no erosion observed near the crest.

The locations of both the emergency spillway chute and outlet discharge structure were different than shown on the plans. The approximate location as constructed is shown on the Plan View in Appendix I.

Three seepage areas were observed and are shown on the Plan View in Appendix I. Area 1 is in the emergency spillway channel and Area 2 is on the abutment slope about 70 feet below the dam crest. Although the seepage in areas 1 and 2 appeared to be from the same source, the temperature of the water in the spillway was 49°F and that on the adjacent abutment slope was 56°F. The seepage was estimated at 30 g.p.m. in the spillway and at 4 g.p.m. on the slope. The water was clear in both locations, but the larger flow in area 1 is causing some erosion in the spillway chute. Area 3 was the smallest area with a flow estimated at 1 to 2 g.p.m. It is located near the toe of the dam on the right abutment.

Bedrock exposed near the spillway was reddish shale and sandstone. The overburden materials were predominantly clay with silt and reddish shale and sandstone rock fragments.

The reservoir area is forested with very uniform slopes, at inclinations of about 12 percent. The downstream channel is rocky and drops sharply at a point about 200 feet below the dam.

A small group of trees within the reservoir is still standing but the trees are dead. These trees should be removed to prevent blockage of the emergency spillway when the trees fall into the reservoir.

3.2 Evaluation: Three areas need to be corrected or examined in greater detail: the riprap, the emergency spillway design, and the seepage. According to the owner's representative, the Commission of Game and Inland Fisheries anticipates revising the spillway, widening the base of the dam and repairing the riprap. However, plans have not been prepared to date. There were no visible cracks or other signs of sizeable distress in the embankment.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: There is no formal operating procedure for the dam. Normally all gates are closed and the flow over the principal spillway regulates the level of the reservoir. Occasionally during conditions of low flow into Tumbling Creek, the outlet is opened to provide flow augmentation.

4.2 Maintenance: There is no regular maintenance of the site. Required maintenance is handled through the Virginia Commission of Game and Inland Fisheries, Richmond Office.

4.3 Maintenance of Operating Facilities: No regular maintenance.

4.4 Description of Any Warning System in Effect: None

4.5 Evaluation: The operation and maintenance procedures in effect seem generally adequate for what little operation is involved.

A warning procedure should be developed to notify downstream inhabitants of an impending dam failure, should such a situation occur. The procedure should spell out the condition which would require warning downstream inhabitants.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: There are no hydraulic or hydrologic design data available.

5.2 Hydrologic Records: None

5.3 Flood Experience: No records are kept but, based on observations of maintenance personnel, the maximum water level is believed to have been about 0.7 feet over the emergency spillway.

5.4 Flood Potential: The design features of the spillway were determined for this report by routing the probable maximum flood (PMF), one-half the PMF, and 100-year floods over the spillway. This information is further presented in Section 5.6, Overtopping Potential. These analyses pertain to present hydrologic conditions and do not consider future uncertain conditions, such as urbanization or other changes in the watershed.

5.5 Reservoir Regulation: None, except for occasional flow agumentation to Tumbling Creek.

5.6 Overtopping Potential: The PMF, one-half the PMF, and the 100-year flood hydrographs were developed for the Laurel Bed Reservoir drainage basin and routed through the reservoir.

The hydrographs were developed and routed by using the HEC-1 computer program (Reference 2 of Appendix IV) and appropriate precipitation, unit hydrograph, and storage volume versus outflow data as input. The triangular unit hydrograph was developed from the drainage area and estimated time to peak (Reference 3 of Appendix IV). Probable maximum precipitation and 100-year precipitation data were obtained from U. S. Weather Bureau publications (References 4 and 5 of Appendix IV). Appropriate reduction factors were applied to the PMF as directed by the Corps of Engineer guidelines. Information from design drawings was used to compute the storage-outflow relationship. Losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.42 inch/hr.

The probable rise in the reservoir and other pertinent information is given in Table 5.1 following.

The results indicate that the spillway cannot pass the PMF flood but can pass up to 50% of the PMF before the dam is overtopped. A 100 year flood can be passed through the spillway with three feet of freeboard.

5.7 *Reservoir Emptying Potential:* Reservoir drainage is provided by the 20-inch bottom outlet. The two shallow 8-inch outlets can also be used initially but they would not significantly reduce the drainage period. If an average inflow to the reservoir of 5 c.f.s. is assumed, it will take approximately 80 days to lower the pool from the level of the principal spillway to the level of the bottom inlet.

Table 5.1 - RESERVOIR PERFORMANCE

Item	Flood		
	One Percent (a)	1/2 PMF	PMF (b)
Peak Discharge, c.f.s.:			
Inflow -	2240	5830	11,700
Outflow -	170	1260	6,550
Peak Elevation, ft (assumed datum)	141.9	145.0	147.5
Principal Spillway:			
Depth Over Crest	2.9	6.0	8.5
Emergency Spillway:			
Depth of Flow, ft (c)	0.9	2.8	4.4
Avg. Velocity, f.p.s.	5.3	9.6	11.9
Non-Overflow Sections:			
Depth of Flow, ft (c)	-	-	1.6
Avg. Velocity, f.p.s.	-	-	7.1
Duration, hours			8.0

Notes:

(a) The 1 percent exceedence frequency flood has one chance in 100 of being exceeded in any given year.

(b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

(c) Critical depth.

5.8 Evaluation: The screening criteria contained in Reference 1 for assessing the adequacy of the spillway design flood allow essentially no risk of loss of life from dam failure by overtopping. Experience indicates that very few existing non-Federal dams were designed with such conservative criteria. Therefore, the Phase I inspection findings will indicate noncompliance with the spillway design flood screening criteria for most non-Federal dams. In accordance with the U.S. Corps of Engineers' Engineer Technical Letter No. 1110-2-234, general criteria are needed for determining that the spillway capacity at a specific dam is seriously inadequate. The spillway is considered seriously inadequate if all three of the following conditions exist:

a. There is high hazard to loss of life from large flows downstream of the dam.

b. Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

c. The spillway is not capable of passing one-half of the probable maximum flood without overtopping the dam and causing failure.

The emergency spillway capacity was calculated at 50% of the PMF. Based upon Section 3.5.1 of Reference 1 the spillway is inadequate but according to the above ETL general criteria it is not "seriously inadequate." A main concern with the emergency spillway is that the surface materials at the crest may not be able to withstand the erosion potential of a large discharge. Immediate attention should be given to protecting the spillway surface against erosion. Future consideration should be given to providing emergency spillway capacity to the PMF design flood.

SECTION 6 - DAM STABILITY

6.1 Stability Analysis: There are no available stability analyses, boring data, or test data on embankment soils.

6.2 Foundation and Abutments: The drawings and specifications give little information concerning the foundation for the dam. No boring data are available. The specifications call for the removal of spongy material, but do not call for excavation to rock. The type of materials to be used for the embankment was also unspecified.

The specifications called for clean clay compacted to 100 percent of optimum density. A core trench was specified to have a width of 19 feet at the top and a minimum depth of 3 feet. No construction records are available.

6.3 Evaluation: Based on the visual inspection, the dam does not exhibit signs of distress. However, the overall static stability cannot be assessed because of the lack of stability analyses, boring data, soils data, or construction test data on embankment soils. The configuration of the dam corresponds with the side slopes recommended in Reference 3 for homogeneous dams, but the top width is too narrow. Reference 3 recommends a top width of 10 feet plus one fifth of the height of the dam. Using this guide, a top width of 20 feet is required, ten feet wider than the existing top width.

The seepage is in low to moderate amounts and has produced no visible signs of piping. Present observations indicate a flow approximating that which was monitored in 1970.

The dam is located within Zone 2 on the Algermissen Seismic Risk Map of the United States (1969 Edition) and there are uncertainities with respect to the static stability of the dam, as set forth in Section 6.3. Therefore, in accordance with paragraph 3.6.4 of Reference 1, additional assessments with respect to the seismic stability of the dam should be made based on the results of studies outlined in Section 7.2.2.

SECTION 7 - DAM ASSESSMENT/RECOMMENDATIONS/REMEDIAL MEASURES

The assessment, recommendations and remedial measures contained in this Report are based on the provisions of Appendix V, Conditions.

7.1 Dam Assessment: The spillway can handle up to 50 percent of the PMF flood before the dam would be overtopped. The emergency spillway crest is formed of in-situ soils and does not appear to have sufficient protection against erosion.

The condition of the embankment and foundation is largely unknown. The visual inspection revealed that the downstream slope is steeper than called for in the plans, which in itself calls for some corrective action, but the lack of a stability analysis and information on the properties of the embankment soils calls for a complete program of borings, testing, and analysis.

The top width of the embankment is also too narrow according to U.S. Bureau of Reclamation (U.S.B.R.) guidelines (Reference 3). The riprap protection of the upstream slope appears to be deteriorating, but erosion so far has been slight. This condition should be monitored and corrected if it worsens.

7.2 Recommendations and Remedial Measures: The following actions are recommended for the Owners consideration and implementation:

7.2.1 Flood Impact Study: It is recommended that the Owner enlist the services of a qualified consultant to analyze the downstream area and to define the area affected by a flood wave resulting from a dam failure. The analysis should determine the effects of a failure at the following pool levels: normal, 1 percent storm, 1/2 PMF and PMF. Emphasis should be placed on the estimated property damage and potential loss of life. The recommended analysis should be completed within 120 days after receipt of this report.

7.2.2 Stability Analysis: It is recommended that the Owner enlist the services of a qualified consultant to evaluate the stability of the dam through a detailed subsurface investigation program. Based upon the findings of the study, the consultant should make recommendations concerning increasing the width of the dam at the base and also at the top. This evaluation should be carried out within 90 days and the consultants recommendations acted on within 180 days of receipt of this report.

7.2.3 Spillway Redesign: The emergency spillway should be protected against erosion. It is recommended that the owner enlist the services of a consultant to design a paving material for the spillway crest which will resist erosion. The emergency spillway capacity was not found to be "seriously inadequate", but future consideration should be given to enlarging it in order to meet the PMF design flood criteria. This work should be carried out in conjunction with the recommendations in Section 7.2.2.

7.2.4 Inspection Program: We recommend that the Owner establish a semi-annual inpection program to monitor the conditions at the dam. Particular attention should be given to monitoring seepage rates and wear of the riprap on the upstream face of the dam.

7.2.5 Warning System: A detailed emergency warning system should be developed as soon as possible to notify the downstream inhabitants of an impending dam failure. In order for the warning system to be effectively applied, a study of the downstream area should be made so that the areas subject to flooding as a result of a dam break can be identified. This work should be completed within 30 days of receipt of this report.

7.2.6 Design Documents: A complete set of available design documents should be maintained by the Owner. These files should include available design drawings, calculations, pertinent correspondence and maintenance records.

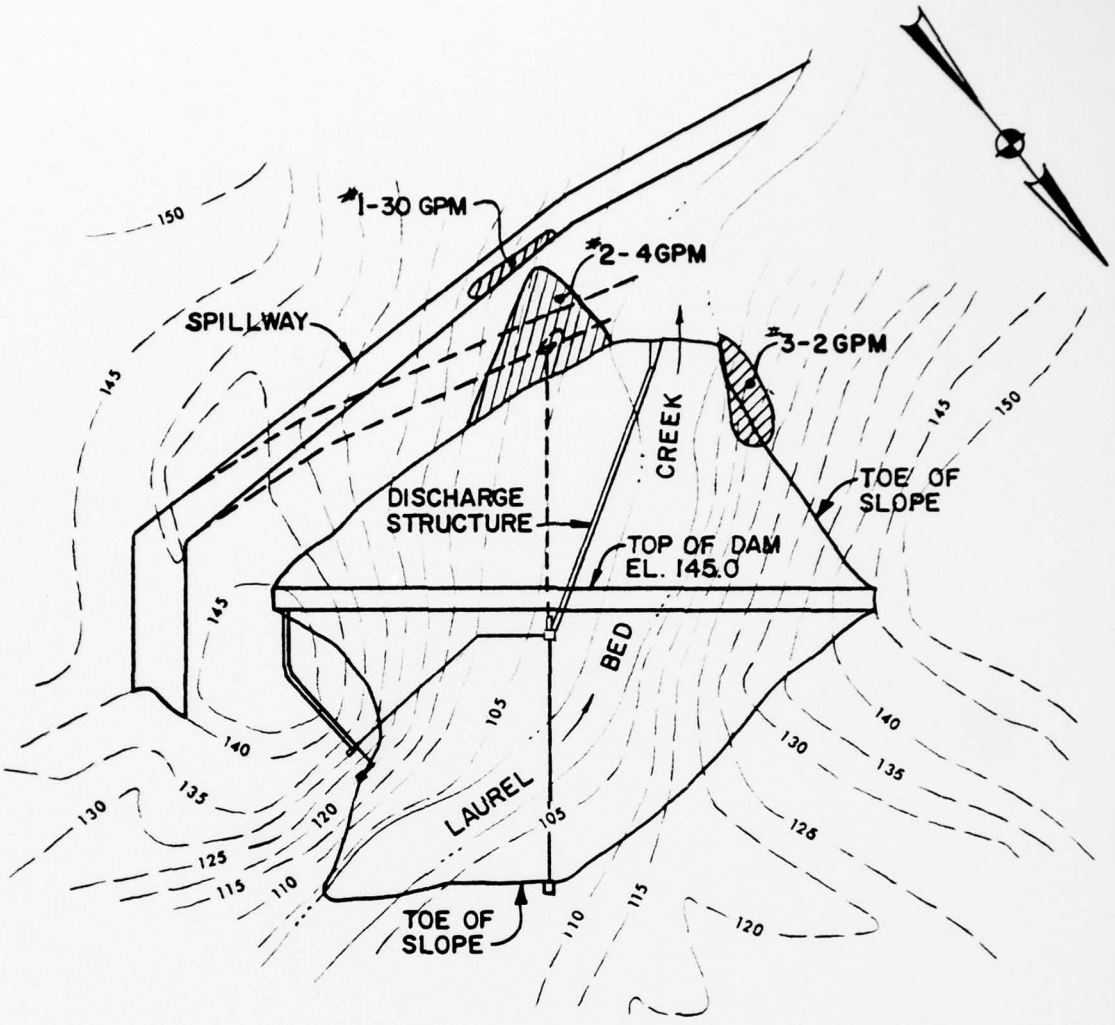
7.2.7 Removal of Dead Trees: The dead trees in the reservoir area should be removed within 90 days.

APPENDIX I

MAPS AND DRAWINGS

LAUREL BED

FIGURE 1



LEGEND

SEEPAGE AREAS

AS-BUILT LOCATION

ORIGINAL PLAN LOCATION

REFERENCE:

COMMISSION OF GAME AND INLAND FISHERIES - PROPOSED LAUREL BED LAKE - SHEET 2 OF 3 - OCTOBER 1966

FIGURE 2

PLAN VIEW

LAUREL BED DAM

NO SCALE:

ATTACHMENT 61-A

COMMONWEALTH OF

COMMISSION OF GAME AND

PROPOSED LAUREL

RUSSELL COUNT

DRAINAGE AREA ----------
TOTAL IMPOUNDMENT AREA---
TOTAL SHORE LINE LENGTH -
MAXIMUM WATER DEPTH-----
DAM : 280FT LONG . MAX. HEI

APPROX ENGINEERING ESTIMATE -- $60,000.00
CLEAR AND GRUB DAMSITE---------- 2.0 AC.
COMPACTED EARTH FILL---------- 29,000 C.Y.
RIP RAP, LOCAL FIELD STONE--------745 TONS
CONCRETE---------- 40 CY.
20" C I P UNDER-DRAIN W/GATE VALVE - 245 FT.
42" REINF. CONC. PIPE ---------- 32 1/2 FT.
CLEARING---------- III AC.
MISCELLANEOUS---------- 13 1/2 % OF COST

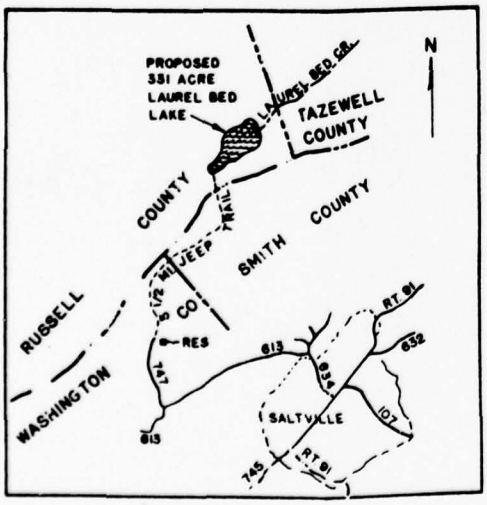
OF VIRGINIA

ND INLAND FISHERIES

L BED LAKE

NTY, VA.

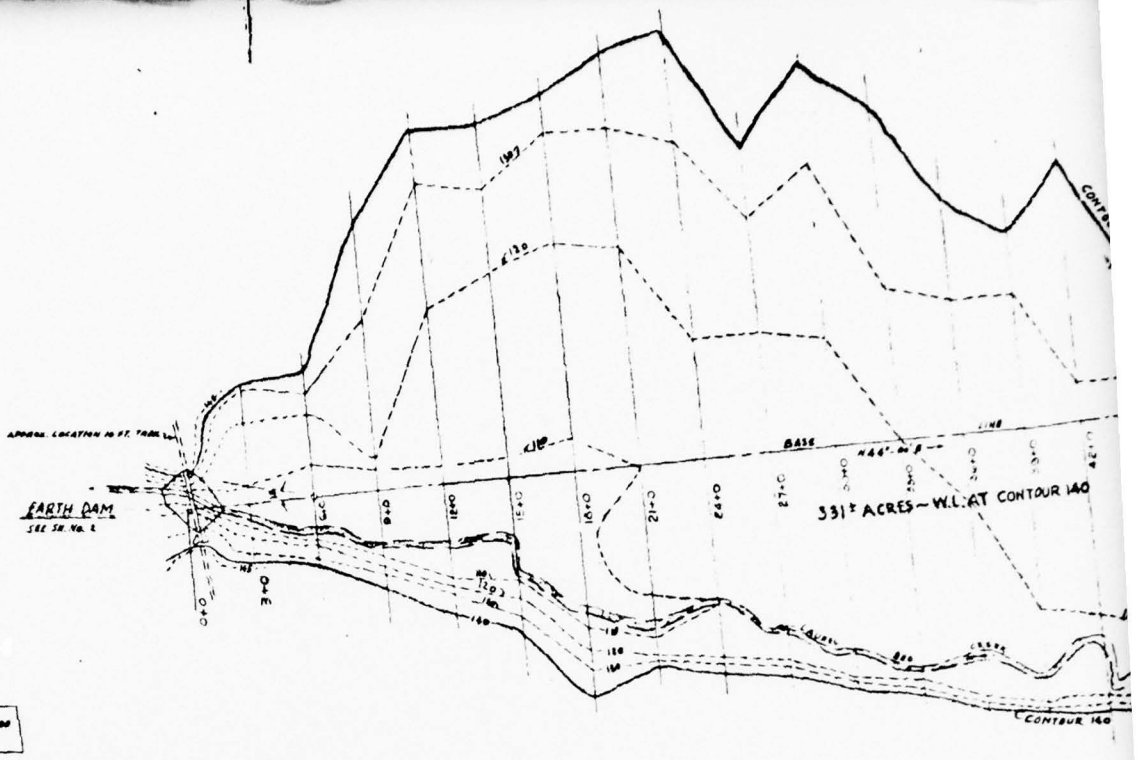
-----2600AC.
EA---- 330 AC.
TH---- 4 1/4 MI.
------- 40 FT.
. HEIGHT 45 FT.



VICINITY MAP
SCALE 1"=2.0 MI

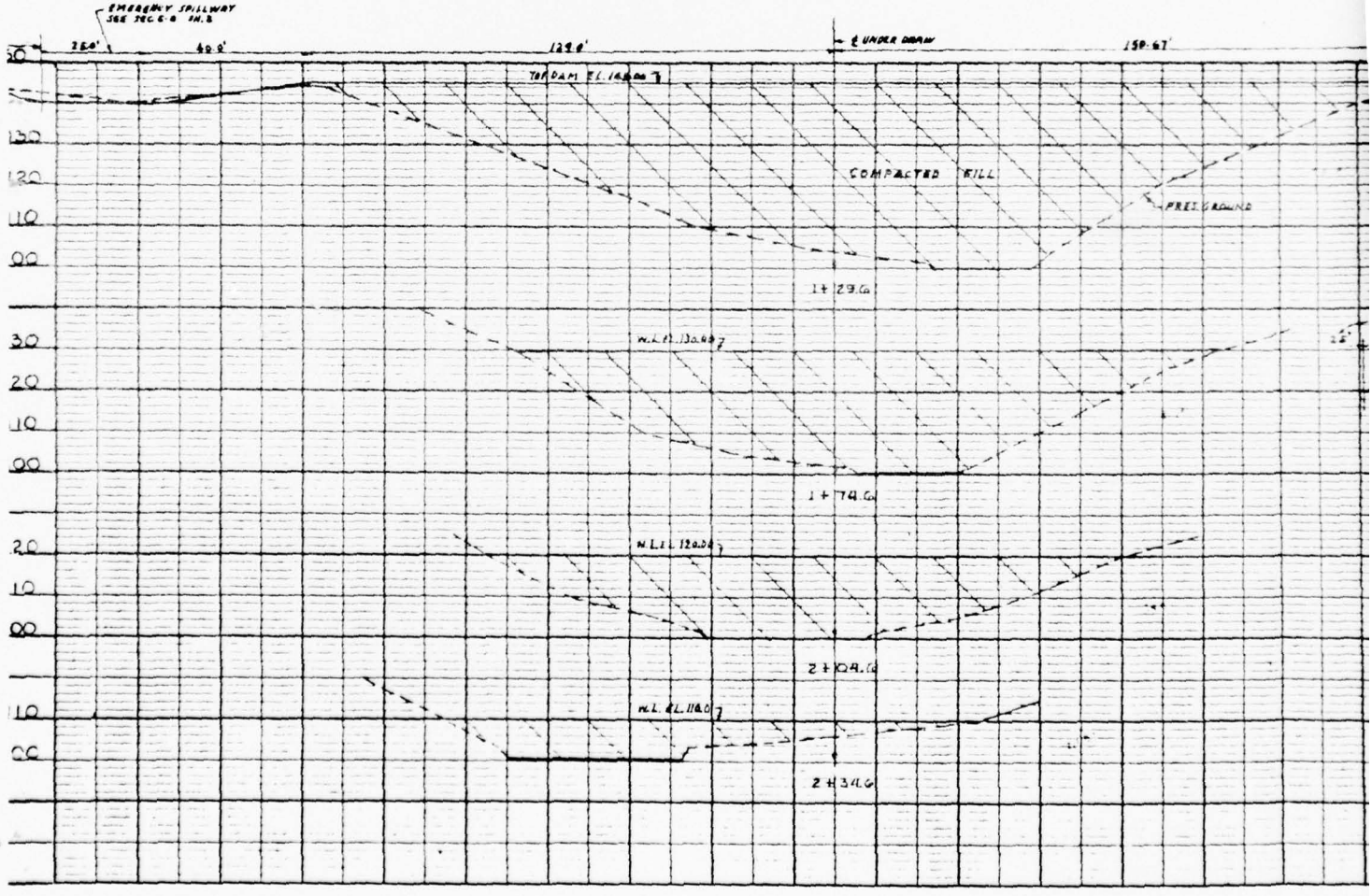
FIGURE 3

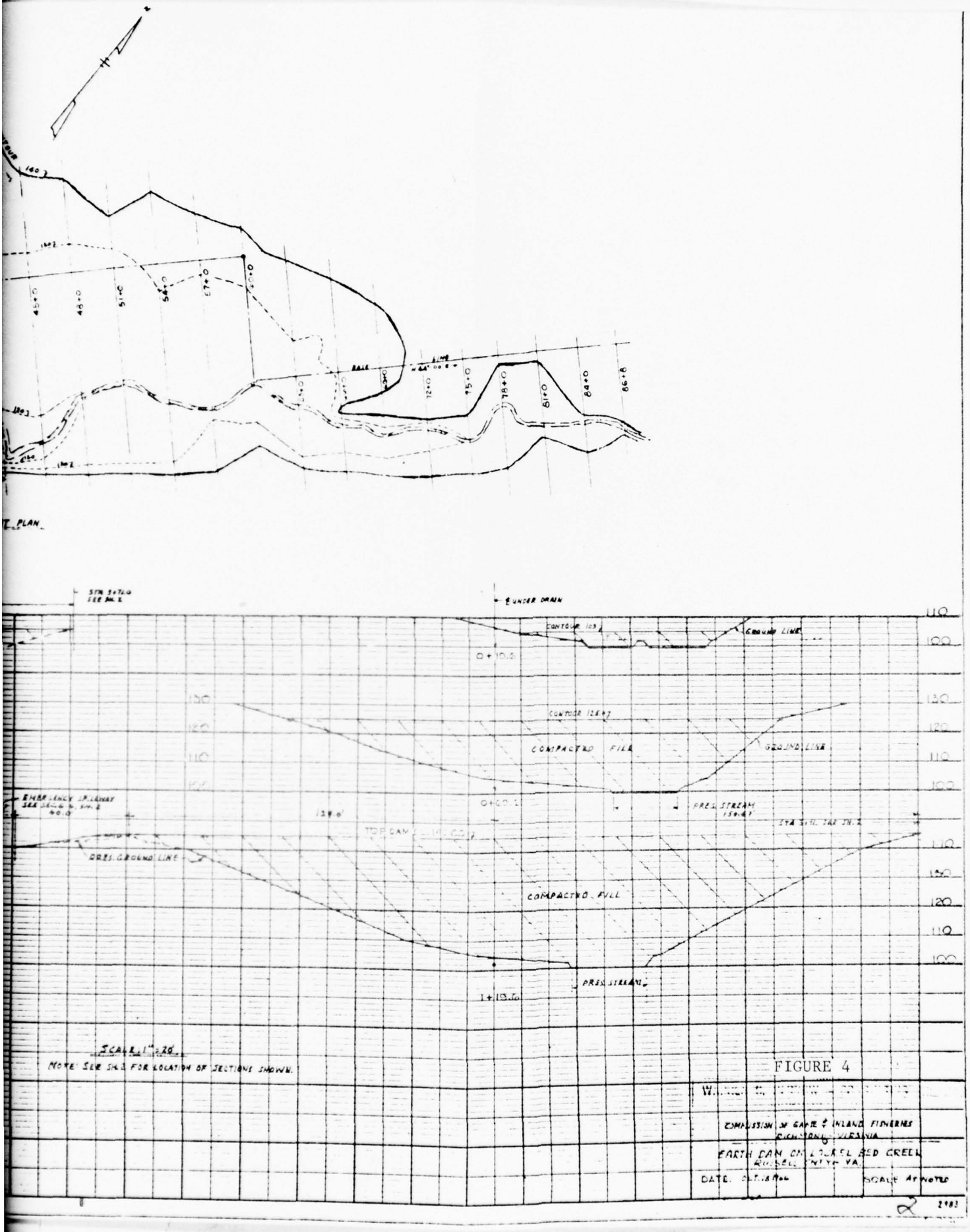
2

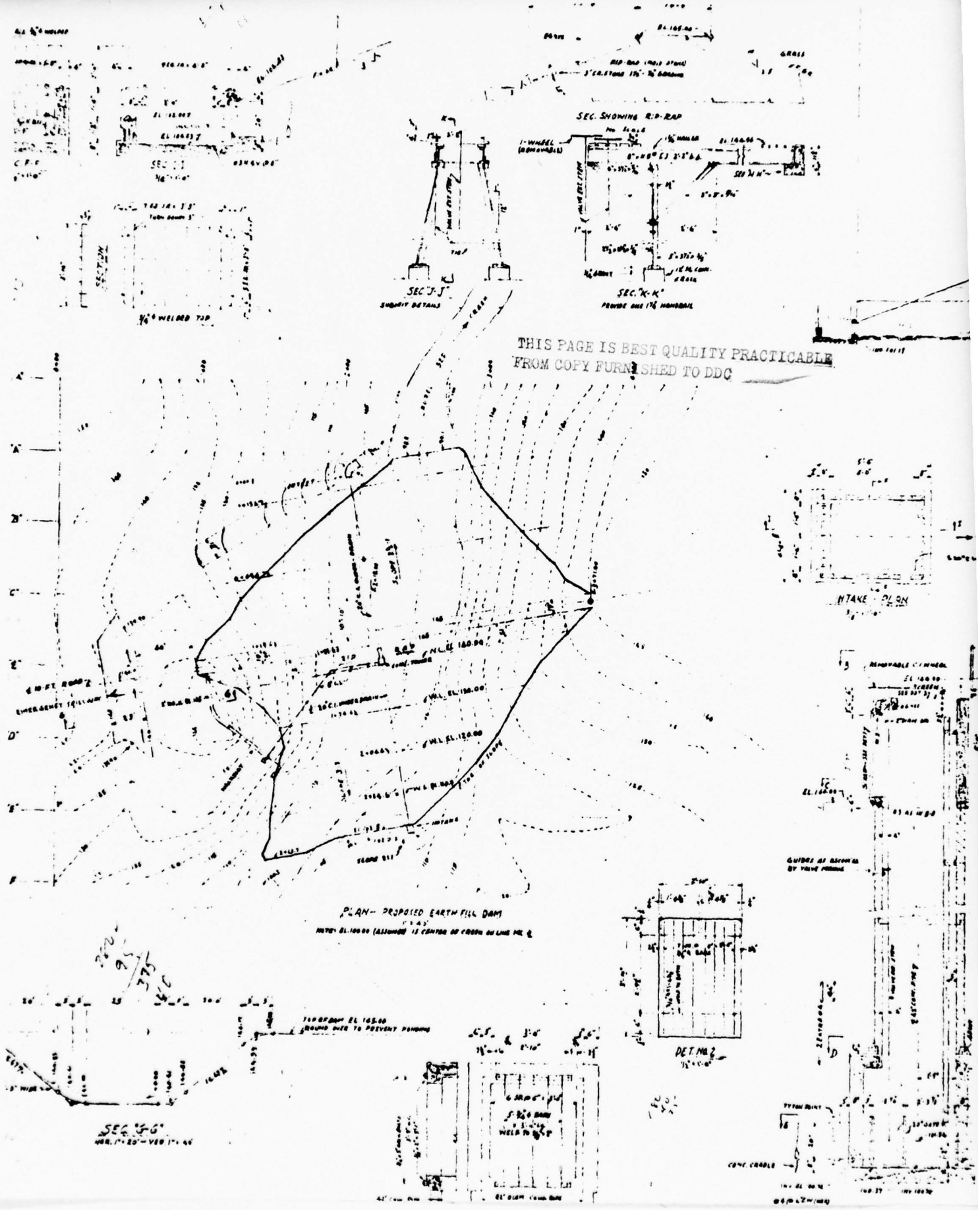


NOTE: B.P. ASSUMED EL. 1000 : ℄ STREAM 376,000 OR EL. 100.7 CHISEL MK ON ROCK

GENERAL LAYOUT




PLAN
45+0
48+0
51+0
54+0
57+0
60+0
72+0
75+0
78+0
81+0
84+0
86+8
STA 0+76.0
SEE SHT. 2
UNDER DRAIN
CONTOUR 103
GROUND LINE
0+10.8
CONTOUR 128.7
COMPACTED FILL
GROUND LINE
EMERGENCY SPILLWAY
SEE SHT. 2
40.0
138.0'
0+60.2
PRES. STREAM
159.4'
STA 3+71.38 IN 2
TOP DAM
PRES. GROUND LINE
COMPACTED FILL
PRES. STREAM
1+19.16
SCALE 1" = 20'
NOTE: SEE SHT. 2 FOR LOCATION OF SECTIONS SHOWN.
FIGURE 4
COMMISSION OF GAME & INLAND FISHERIES
RICHMOND, VIRGINIA
EARTH DAM ON LOWER RED CREEK
RUSSELL CNTY. VA.
DATE: OCT. 1980
SCALE AS NOTED
2
2983



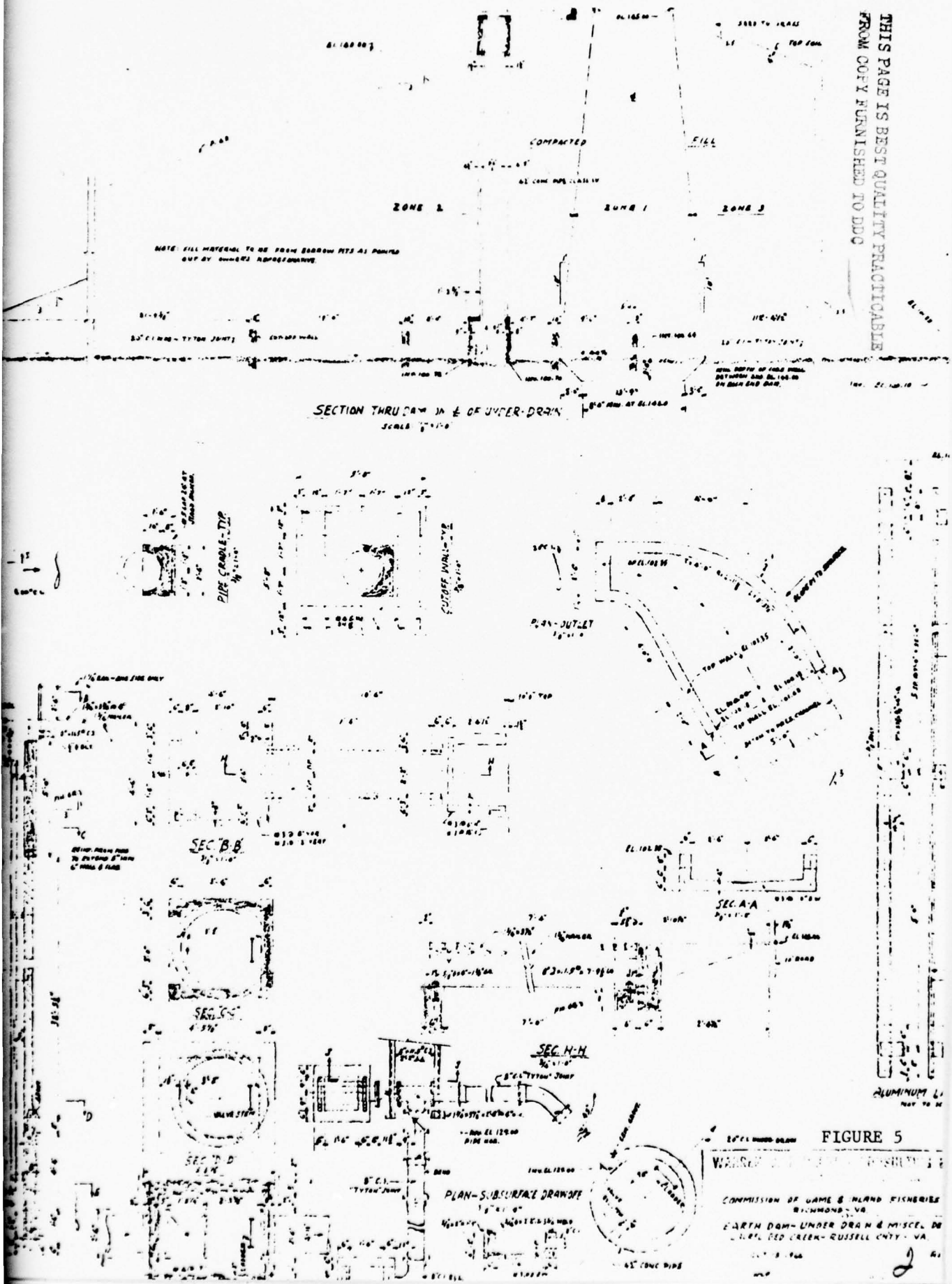
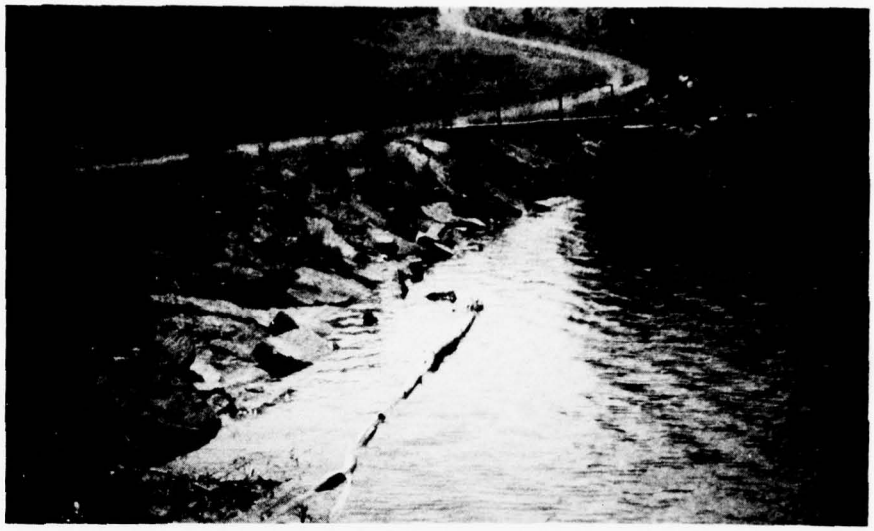


FIGURE 5

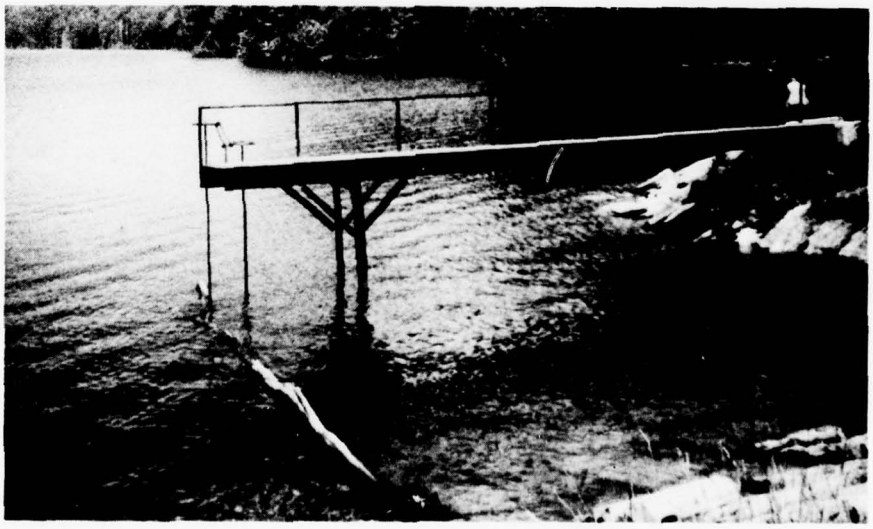
APPENDIX II

PHOTOGRAPHS



June 5, 1978

UPSTREAM FACE OF DAM SHOWING PRINCIPAL SPILLWAY
AND DETERIORATING RIPRAP



June 5, 1978

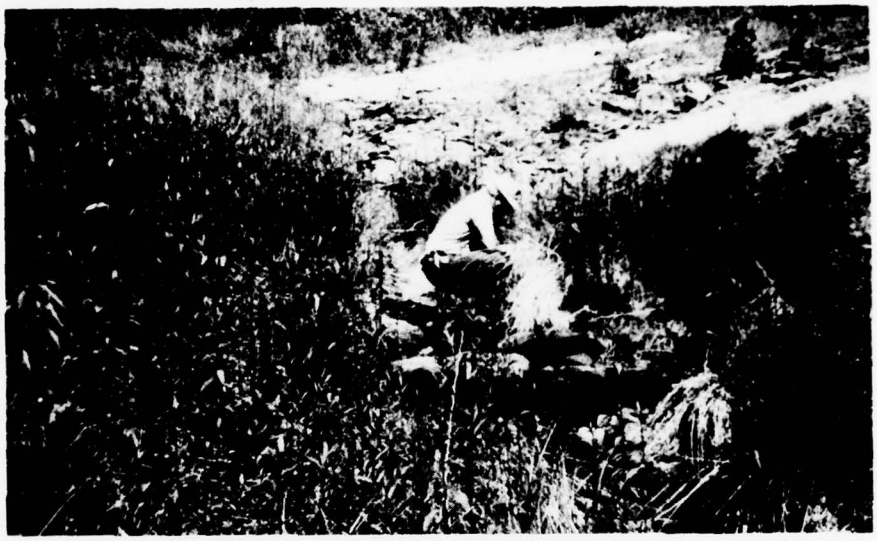
BRIDGE AND CONTROL RODS TO THE TWO 8 INCH
SHALLOW RESERVOIR OUTLETS

June 5, 1978

VIEW FROM TOP RIGHT OF DAM LOOKING
DOWNSTREAM AT OUTLET

June 5, 1978

OUTLET STRUCTURE



June 5, 1978

VIEW FROM EMERGENCY SPILLWAY CHUTE LOOKING
UPSTREAM AT EROSION AND SPRING AREA.

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam: Laurel Bed County: Russell State: Virginia Coordinators: Norfolk District, Corps of Engineers

Date(s) Inspection: June 5, 1978 Weather: Clear, Warm Temperature: 72°F

Pool Elevation at Time of Inspection: 140.1 Assumed Datum Tailwater at Time of Inspection: 99.5 Assumed Datum

Gilbert Associates, Inc.
Inspection Personnel:

Thomas E. Roberts
William J. Santamour
Thomas W. Schreffler

Also Present:

R. W. Wollitz - Virginia Game and Inland Fisheries
Buck Arnold - Virginia State Water Control Board

Thomas W. Schreffler - Recorder

EMBANKMENT

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None Observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None Observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None Observed	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Crest appeared to be straight both vertically and horizontally.	
RIPRAP FAILURES	Riprap consists of large stones scattered over 2 inch stone layer: No erosion observed but riprap looks like it has been and will be subject to attack from ice.	Riprap does not meet modern design standards and although no serious erosion has occurred the surface is deteriorating. This should be watched closely.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No observed erosion or other structural failure of any of the junctions.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Three areas of seepage were observed, two on the embankment near the abutment and the third in the spillway channel. The major area occurs on the left abutment slope, between the emergency spillway channel and the embankment. The area is mostly on the abutment slope rather than the embankment and covers a triangular area about 50 x 75 feet roughly 70 feet below the dam crest as measured along the slope. The seepage temperature was 56°F and was estimated at 4 g.p.m. This seepage was near the seepage observed in the spillway channel (see DISCHARGE CHANNEL). Difference in temperature indicates they may not be from the same source. The smaller area was on the right abutment. The area was triangular, about 30 x 20 feet, and the seepage was estimated at 1 to 2 g.p.m.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

OUTLET WORKS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING CONCRETE SURFACE IN OUTLET CONDUIT	None Observed.	
INTAKE STRUCTURE	There is a three level intake system. The deep inlet is occasionally used for downstream augmentation. The shallower inlets are not used.	
OUTLET STRUCTURE	A free discharging rectangular concrete chute, eleven feet long and flaring from 18 inches at the end of the discharge pipe to 5 feet.	
OUTLET CHANNEL	Natural channel, no serious scouring observed.	
EMERGENCY GATE	None.	

UNGATED SPILLWAY

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	None.	
APPROACH CHANNEL	A natural earth channel with some small rip rap (2"-3") interspersed in low vegetation.	Spillway is a small saddle on the left abutment of the dam. According to the owner's representative, provisions for a new spillway are being developed. Core samples of spillway crest should be taken to assure that underlying materials will not erode, or some sort of channel protection should be provided.
DISCHARGE CHANNEL	A rock channel formed by the left abutment slope and a small dike on the right. A "spring" was observed about 70 feet below the spillway crest. It was flowing at about 30 gpm at 49°F. The seepage has formed a small gully along the lower portion of the spillway channel.	This spring has existed since at least 1970. A small weir was installed and observed from March through July of 1970. Dimensions of the weir were not available from the owner but the depth over the weir dropped from 2 inches in April to 1.25 inches in July. From a rough guess of the weir crest width at 12 inches, the flow would vary from 80 to 40 gpm.
BRIDGE AND PIERS	None.	

APPENDIX V

CONDITIONS

This Report is based on a visual inspection of the dam, a review of available engineering data and a hydrologic analysis performed during a Phase I Investigation as set forth in the U.S. Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams" and the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc.

The foregoing inspection, review and analysis are by their nature limited in scope. It is possible that conditions exist which are hazardous, or which might in time develop into safety hazards, that are not detectable by this inspection, review and analysis. Accordingly, Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous, or which may in time develop into safety hazards, do not exist.

INSTRUMENTATION

Sheet 1

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate slopes around perimeter of reservoir. No slope failures were observed.	The perimeter of the reservoir was observed only in the immediate vicinity of the reservoir.
SEDIMENTATION	No sedimentation was observed.	A very small watershed area relative to the reservoir size. Sedimentation is not likely to cause a problem.
VEGETATION	Dead trees are standing in the reservoir near the emergency spillway.	Remove standing trees in reservoir.

DOWNSTREAM CHANNEL

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No obstructions	
SLOPES	Steep and Rocky	
APPROXIMATE NO. OF HOMES AND POPULATION	There are no homes for approximately 6.5 miles but the area has camping grounds and has a public concession area planned for a site below the dam. Tumbling Creek is heavily fished.	

APPENDIX IV

REFERENCES

APPENDIX IV

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, (Washington, D.C., Department of the Army, Office of the Chief of Engineers).

2. HEC-1 Flood Hydrograph Package, (Hydrologic Engineering Center, U. S. Army Corps of Engineers, January 1973).

3. Design of Small Dams, (U. S. Department of the Interior, Bureau of Reclamation, Second Edition, 1973).

4. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Hydrometeorological Report No. 33, (U. S. Weather Bureau, April 1956).

5. "Rainfall Frequency Atlas of the United States," Technical Paper No. 40, (U. S. Weather Bureau, May 1961).

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